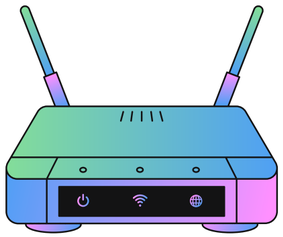
SLTC RESEARCH UNIVERSITY

Antenna and Microwave Communication

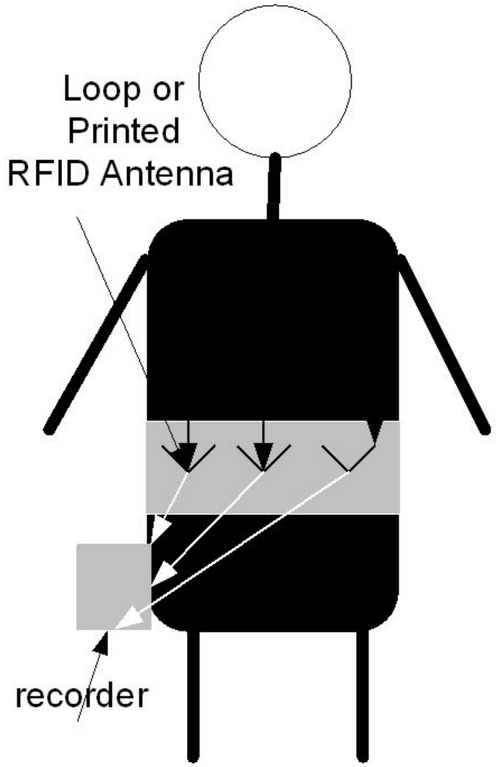


Lecture 2

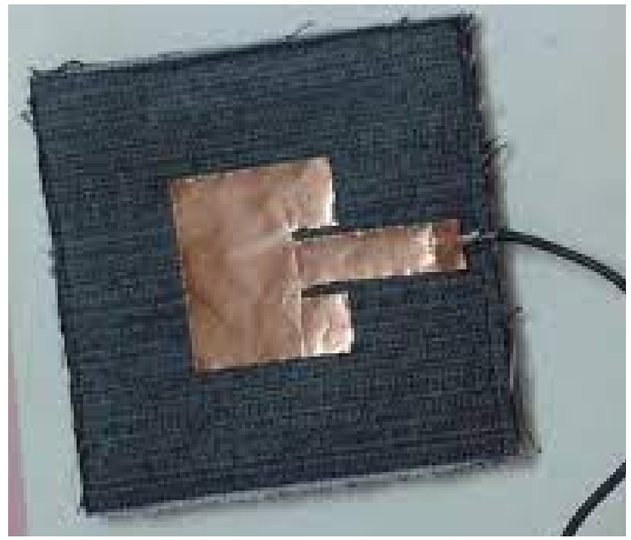
Vishaka Basnayake
vishakab@sltc.ac.lk

Do we need microstrip antennas in our day today life?

Mobile communication



Medical applications



Textile antennae

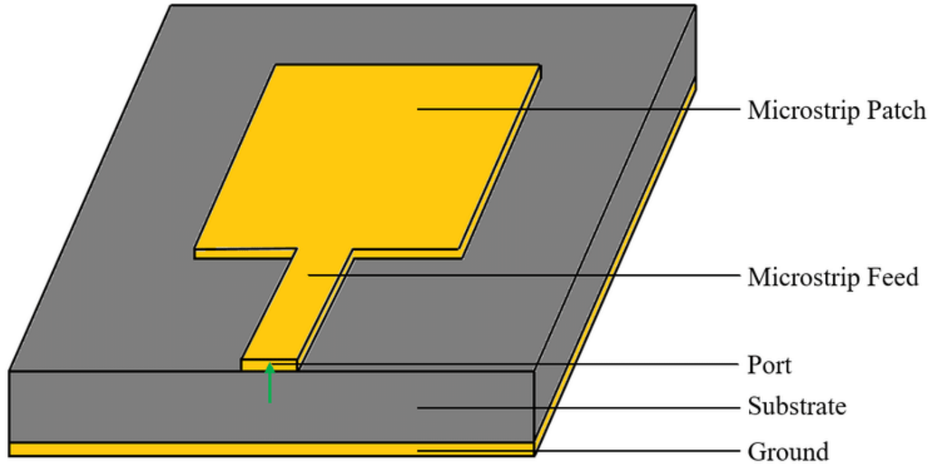
What is a microstrip patch antenna ?

PCB based antenna

Rectangular patch (Length L, Width W)

Fed by microstrip transmission line

Similar to *Half-wave Dipole* Antenna



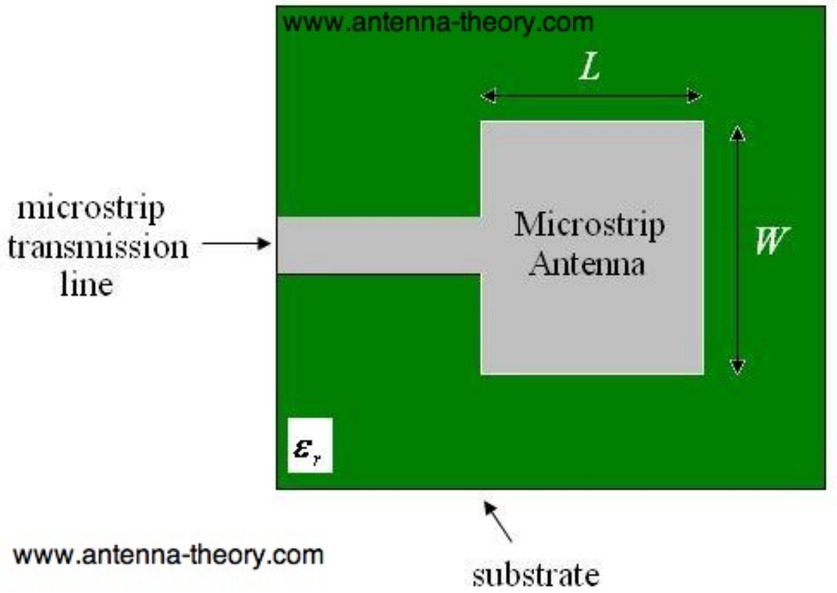
Advantages

Low cost: no additional component required

Fairly easy to design

For the Frequency of interest > = Multiple GHz

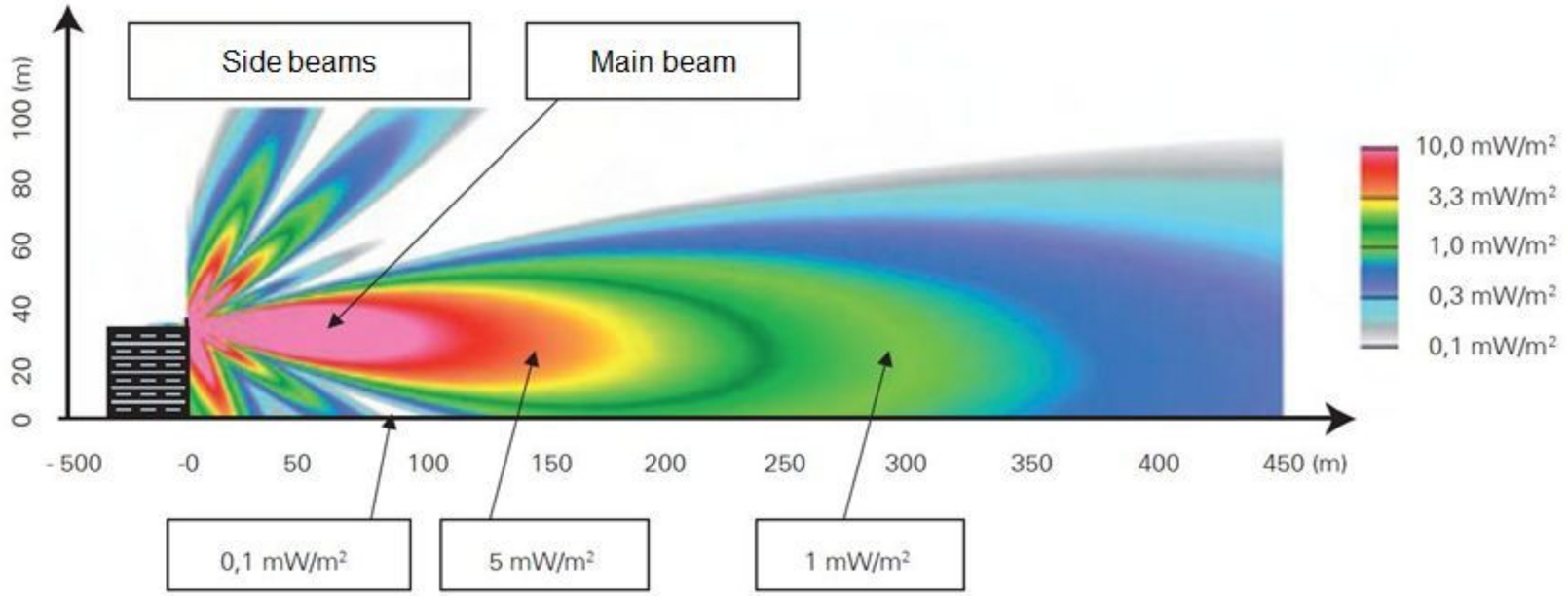
Size of antenna is in the cm range



Antenna performance metrics

Radiation pattern

A radiation pattern defines the variation of the power radiated by an antenna as a function of the direction away from the antenna.



Antenna Efficiency

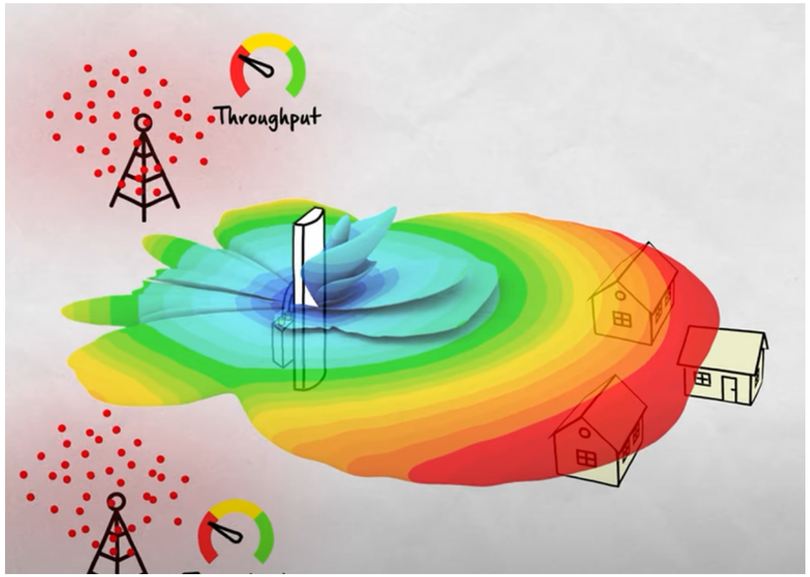
The efficiency of an antenna is a ratio of the power delivered to the antenna relative to the power radiated from the antenna

$$\varepsilon_R = \frac{P_{radiated}}{P_{input}}$$

Antenna Gain

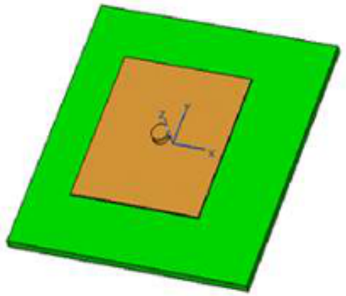
Antenna Gain describes how much power is transmitted in the direction of peak radiation to that of an isotropic source.

Main lobe and Sidelobes

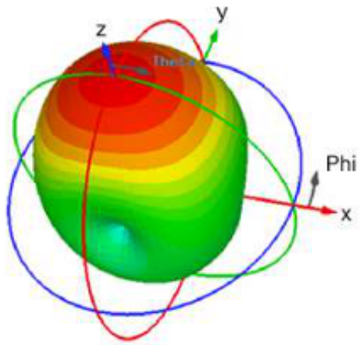


Microstrip patch antenna performance

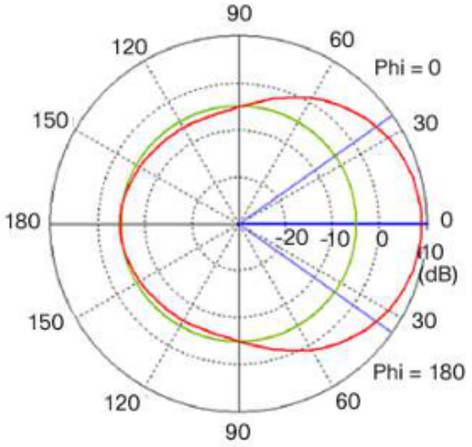
Radiation pattern



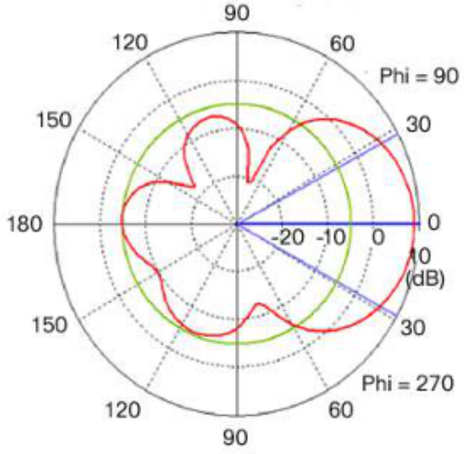
(a) Patch Antenna Model



(b) Patch Antenna 3D Radiation Pattern

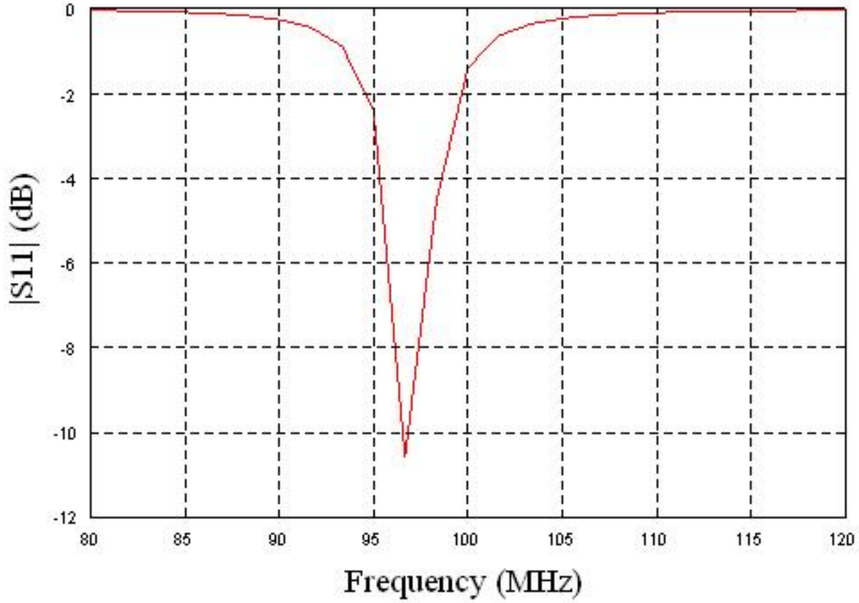


(c) Patch Antenna Azimuth Plane Pattern



(d) Patch Antenna Elevation Plane Pattern

Return loss



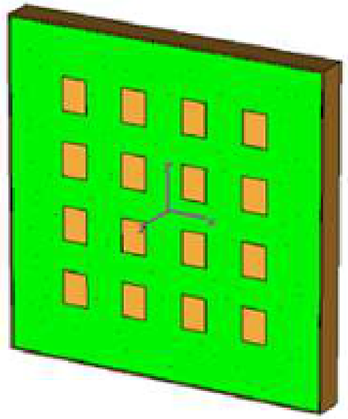
Precision is required: achieve the required resonance frequency

Antenna Gain

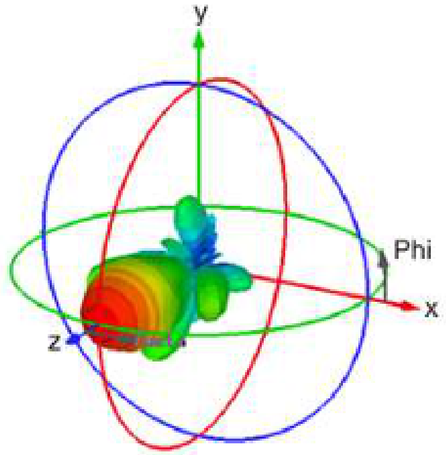
5 dB < Antenna Gain < 10 dB

Microstrip patch antenna array performance

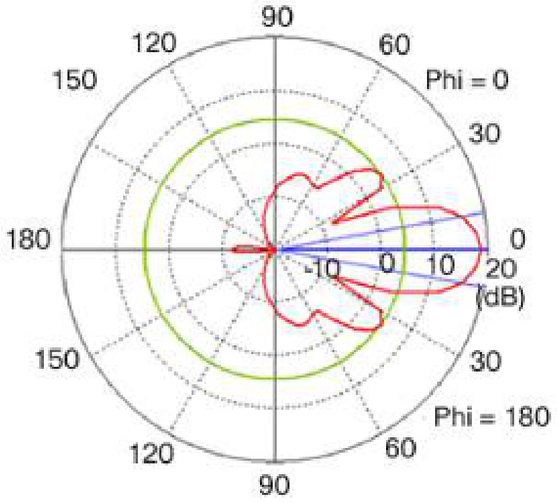
Radiation pattern



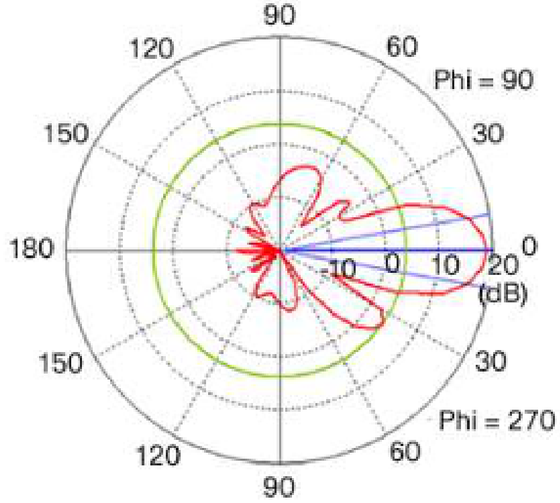
(a) 4x4 Patch Array Antenna



(b) 4x4 Patch Array 3D Radiation Pattern



(c) 4x4 Patch Array Azimuth Plane Pattern



(d) 4x4 Patch Array Elevation Plane Pattern

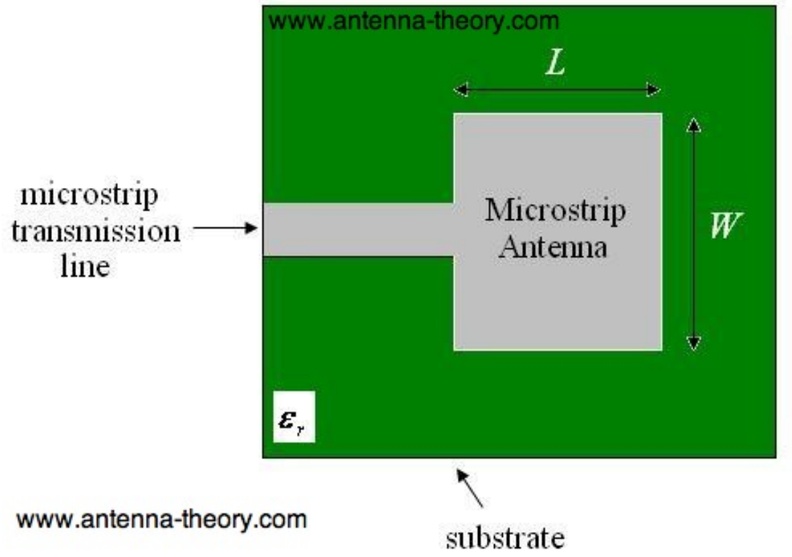
Microstrip patch antenna performance

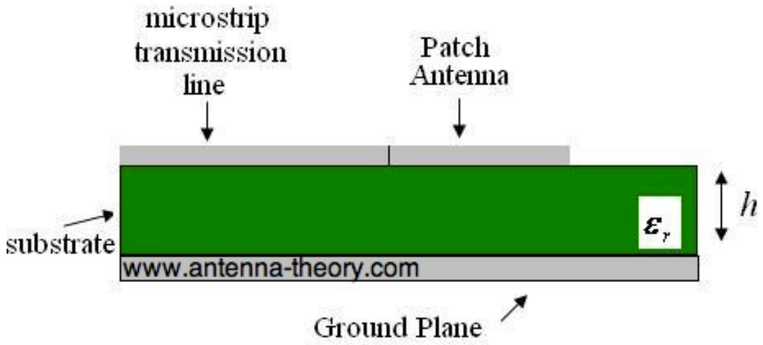
Standing wave along the length of the patch

Linear Polarization

Because the microstrip is bounded on top by air the effective permittivity need to be computed

Fringing fields at the antenna edges

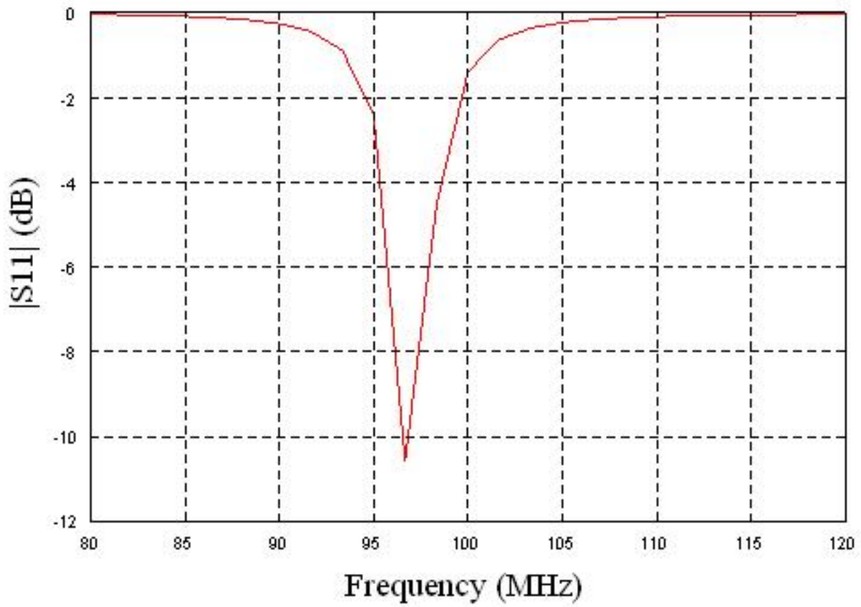




Design of microstrip antenna

Due to the fringing fields at the antenna edges, the resonance frequency is shifted

Need to trim the length by a small amount to get the desired resonant frequency



Design of microstrip antenna

Calculating the width

- Determines input impedance
- Bandwidth
- Radiation pattern

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

f_0 = Resonance Frequency
ϵ_r = Relative Permittivity of the dielectric substrate
c = Speed of light = $3 \text{ x } 10^8$

Increasing W - Decreases input impedance

- Very wide patch antenna

Design of microstrip antenna

Effective dielectric constant

Antenna sits on top of dielectric substrate

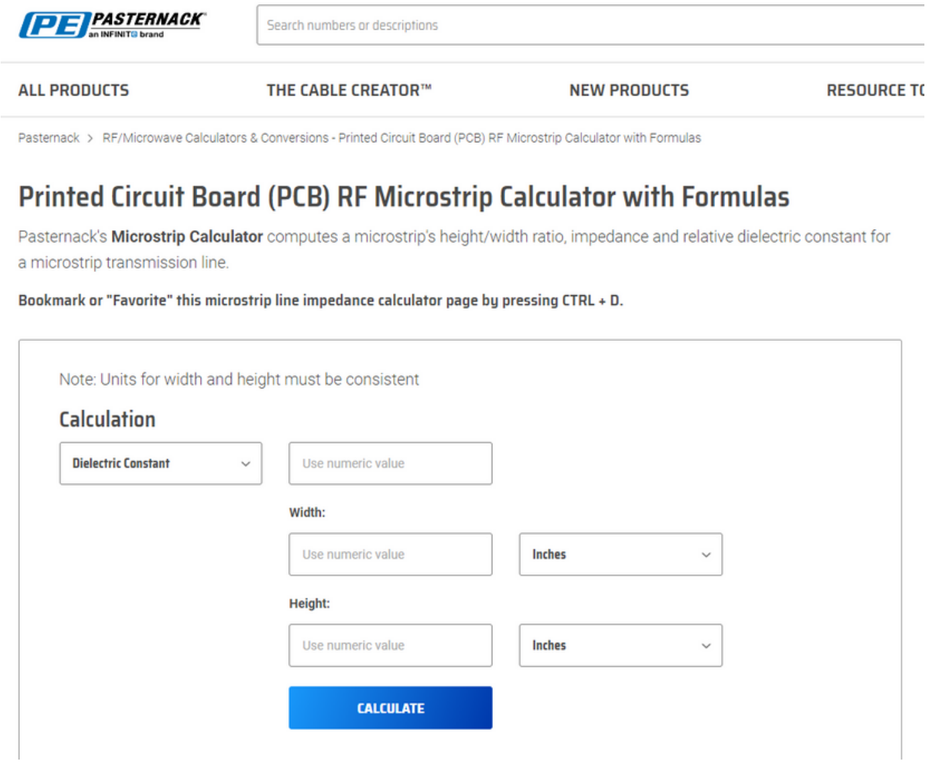
$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

h = thickness of substrate

Design of microstrip antenna

Can use an online tool to compute the effective dielectric constant

https://www.pasternack.com/t-calculator-microstrip.aspx



Design of microstrip antenna

Length

$$L_{eff} = \lambda/2$$

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}}$$

Length extension ΔL

$$\Delta L = 0.412h\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)}$$

Actual length of the patch

$$L = L_{eff} - 2\Delta L$$

Design of microstrip antenna

emtalk.com

em: talk
Electromagnetics & Microwave Engineering

Home | Company Info | Blog | **Tutorials & Tools** | Forums | Store | Services | Contact | Site Map

Like 267

RF & Microwave Engineering Tutorials/Tools

Microwave Theory 101

Antenna Theory: Part I NEW
Covers basic antenna theory including gain, directivity, dipole, monopole, and arrays.

Patch Antenna: From Simulation to Realization
Simulation of a 2.4 GHz patch antenna with experimental results.

Ansoft HFSS

Tutorial 1: Microstrip Patch Antenna
Simulation setup for microstrip fed patch antenna.

Tutorial 2: Dispersion Diagram I: Parallel Plate
Introduction to dispersion diagrams and eigenmode simulator.

Tutorial 3: Dispersion Diagram II: Sievenpiper Mushroom
How to analyze the Sievenpiper high-impedance structure supporting a backward wave.

Tutorial 4: Left-Handed Materials: Effective Medium Approach
Simulation setup of a flat lens made with negative refractive

Calculators

Noise Figure Calculator NEW
Calculate noise figure, gain, and noise temperature for a N-Stage cascade device.

VSWR Calculator NEW
Calculate voltage standing wave ratio (VSWR) and return loss for mismatched circuit.

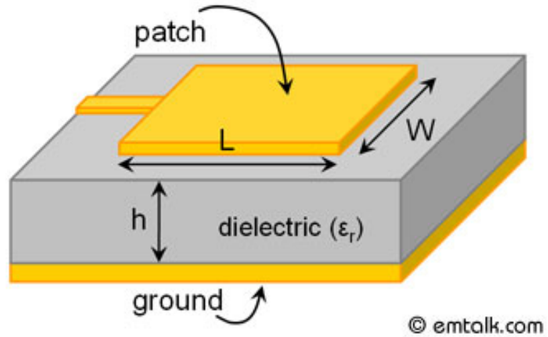
Microstrip Patch Antenna Calculator NEW
Calculate dimensions and edge impedance for desired resonant frequency.

Microstrip Line Calculator
Analyze or synthesize a microstrip line based on substrate parameters and frequency.

HFSS Waveport Size Calculator
Figure out the correct waveport size to use in HFSS for a microstrip line feed.

Tools

Microstrip Patch Antenna Calculator



Substrate Parameters

Dielectric Constant (ε_r):

Dielectric Height (h): mm

Resonant Frequency

f_r: GHz

Synthesize

Analyze

Physical Parameters

Length (L): mm

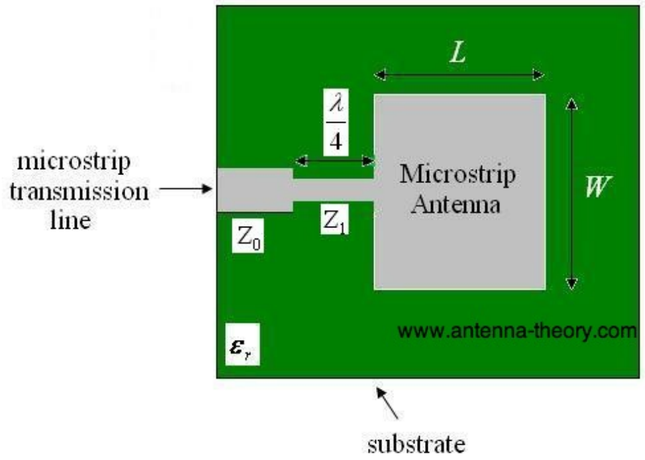
Width (W): mm

Input Impedance (Edge): Ohm

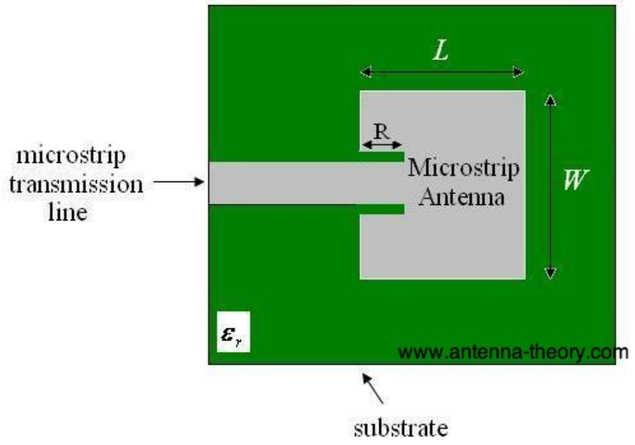
Antenna feed methods

Several Types

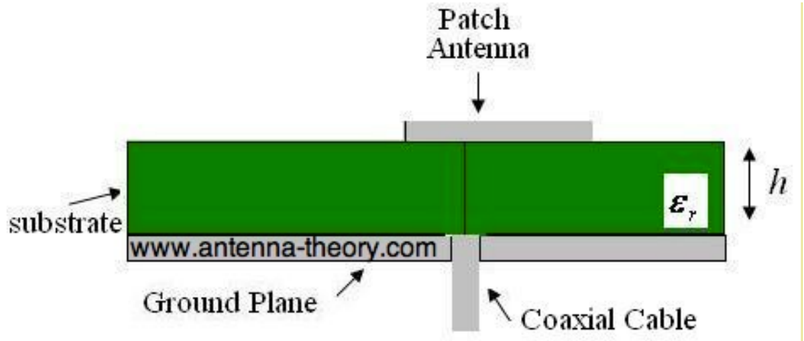
Quarter Wave Transformer based



Inset feed

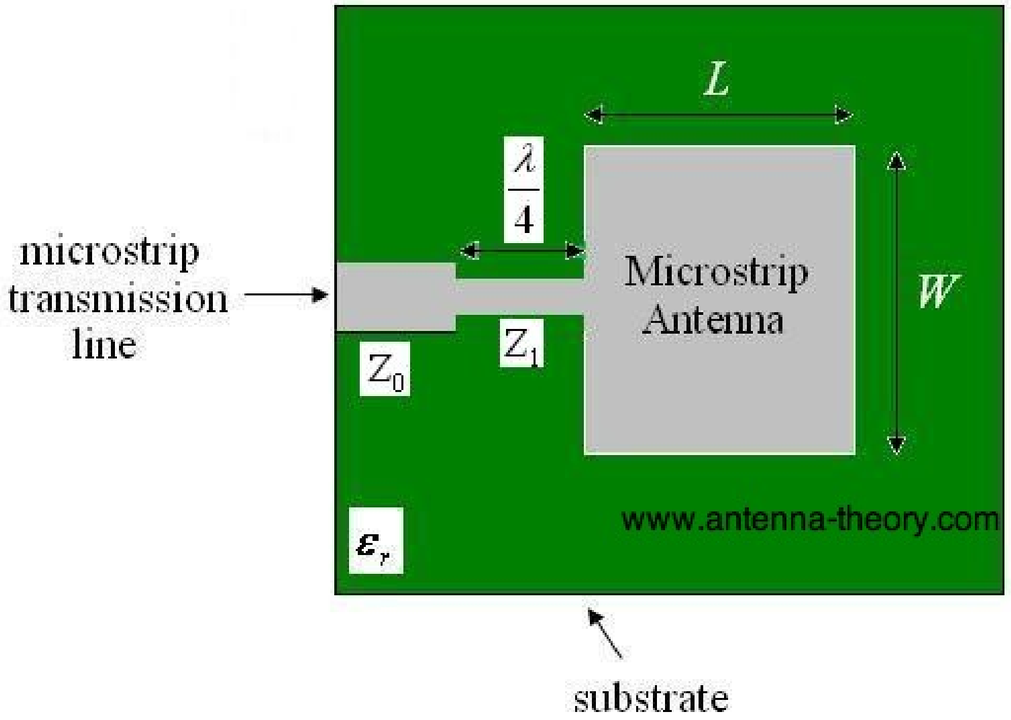


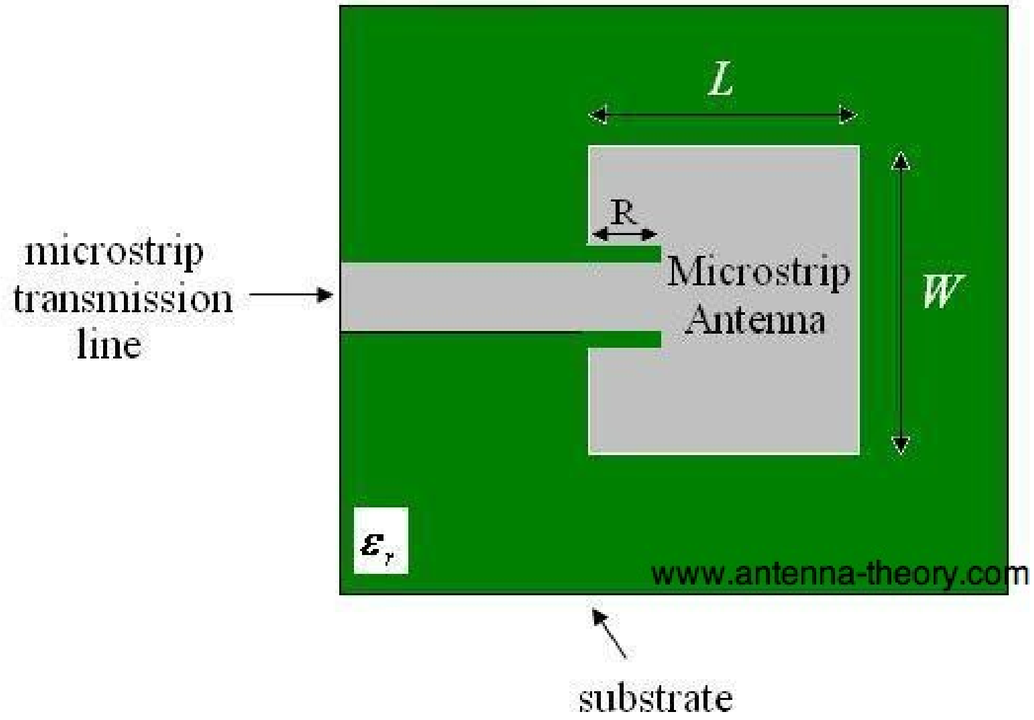
Coaxial feed



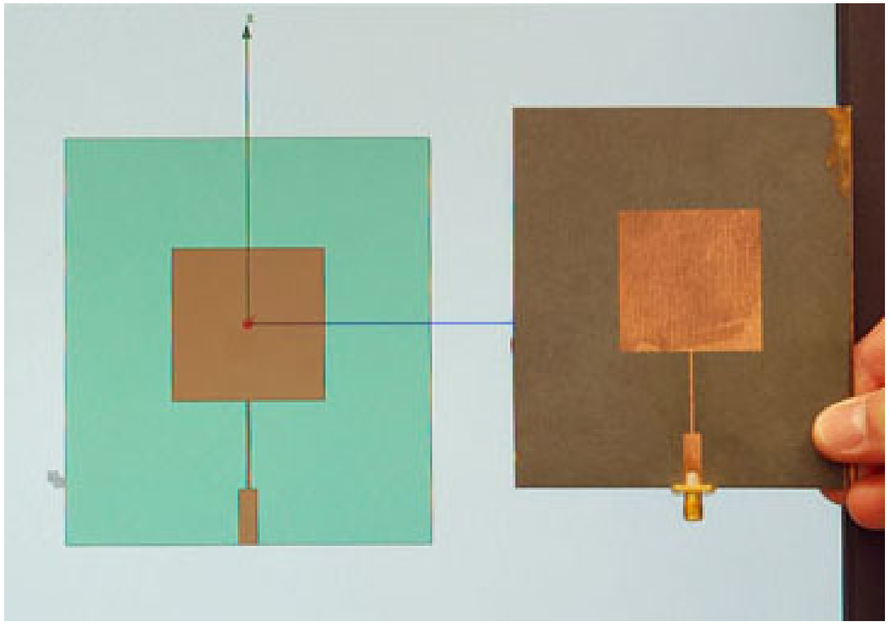
Interative Session 2

Get into groups of 2 and design a QWT microstrip antenna and an inset feed microstrip antenna





Real view of QWT and Inset feed Microstrip antenna



Interative Session 3a

Number and types of antennas in a mobile phone? What are they used for?

Antenna type	Application	Order of Antenna size

Interative Session 3b

Size of antennas for different mobile network generations?

Mobile network Generation	Order of Antenna size